R E P O R T R E S U M E S

ED 010 595 24

AN EXPLORATORY STUDY OF THE RELATIONSHIP OF AUDITORY-VISUAL AND TACTUAL-VISUAL INTEGRATION TO INTELLIGENCE AND READING ACHIEVEMENT.

BY- FORD, MARGUERITE P.
COLUMBIA UNIV., NEW YORK, TEACHERS COLLEGE

REPORT NUMBER BR-6-8055 PUB DATE JAN 67
CONTRACT OEC-6-10-320
EDRS PRICE MF-$0.09 HC-$0.92 23P.

DESCRIPTORS- INTELLIGENCE LEVEL, READING ACHIEVEMENT, *COMPARATIVE ANALYSIS, *AUDITORY VISUAL TESTS, VISUAL PERCEPTION, *TACTUAL VISUAL TESTS, *TASK PERFORMANCE, *MEASUREMENT INSTRUMENTS, NEW YORK CITY, NEW YORK

THE RELATIONSHIP OF AUDITORY-VISUAL AND TACTUAL-VISUAL INTEGRATION TO INTELLIGENCE AND READING ACHIEVEMENT WAS INVESTIGATED. IN ADDITION, THE RELATIONSHIP OF THE TWO INTERSENSORY INTEGRATION TASKS TO EACH OTHER AND TO THE TYPE OF READING ERRORS MADE ON AN ORAL DIAGNOSTIC READING TEST WAS ALSO EXPLORED. THE SAMPLE WAS COMPOSED OF 121 WHITE FOURTH-GRADE BOYS DRAWN FROM A MIDDLE-CLASS SUBURBAN COMMUNITY. THE MEASURE OF TACTUAL-INTEGRATION REQUIRED THE MATCHING OF A GEOMETRIC SHAPE FELT, BUT NOT SEEN, TO ONE OF FOUR VISUAL CHOICES. THE MEASURE OF AUDITORY-VISUAL INTEGRATION REQUIRED SUBJECTS TO MATCH A RHYTHMIC AUDITORY PATTERN WITH ONE OF FOUR VISUAL DOT PATTERNS. THE TACTUAL-VISUAL TEST, AUDITORY-VISUAL TEST, AND THE GATES-MCKILLOP READING DIAGNOSTIC TEST WERE ADMINISTERED TO ALL SUBJECTS. SCORES ON THE HENMON-NELSON INTELLIGENCE TEST AND THE IOWA TESTS OF BASIC SKILLS WERE OBTAINED FROM SCHOOL RECORDS. ALL THE DATA WERE SUBJECTED TO A CORRELATED ANALYSIS. THE RESULTS OF THE STUDY INDICATED THAT AUDITORY-VISUAL INTEGRATION SKILLS WERE SIGNIFICANTLY RELATED TO INTELLIGENCE AND TO BOTH SILENT AND ORAL READING ABILITY, WHEREAS TACTUAL-VISUAL INTEGRATION SKILLS WERE NOT, THE FINDINGS IN THIS CASE DIFFERING MARKEDLY FROM THOSE OF BUCHNER (COLUMBIA UNIVERSITY, 1964). IT WAS RECOGNIZED THAT THESE RESULTS HELD ONLY FOR THE TYPES OF INTERSENSORY INTEGRATION TASKS EMPLOYED AND THAT GENERALIZATIONS TO OTHER TYPES OF INTERSENSORY TASKS COULD NOT BE MADE. (GD)

ED010595

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

6-8055

FINAL REPORT

Project No. OE-6-10-320
Contract No. OE-6-10-320

AN EXPLORATORY STUDY OF THE RELATIONSHIP OF AUDITORY-VISUAL AND TACTUAL-VISUAL INTEGRATION TO INTELLIGENCE AND READING ACHIEVEMENT

January 1967

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

AN EXPLORATORY STUDY OF THE RELATIONSHIP OF AUDITORY-VISUAL AND TACTUAL-VISUAL INTEGRATION TO INTELLIGENCE AND READING ACHIEVEMENT

Project No. OE-6-10-320
Contract No. OE-6-10-320

Marguerite P. Ford

January 1967

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Teachers College, Columbia University

New York, New York

INTRODUCTION

The research reported here is based on the theory of sensory integration derived from comparative psychology (11) and neurophysiology (15) and initially applied to children and the educational process by Birch and his coworkers (3,4,5). Birch has hypothesized

> . . . that some individuals with reading disability are disabled precisely because they have nervous systems in which the development of equivalences between the sensory systems is impaired. The most obvious potential region of impairment would be between the visual and auditory systems, and one would predict that a greater number of children with reading disabilities would exhibit disturbances in the capacity to establish visual-auditory equivalences than would be found in a matched group drawn from the nondyslexic segment of the population. (3, pp. 167-168).

To test this hypothesis Birch and Belmont (4), in a study carried out in Scotland, studied 150 male retarded readers and 50 male normal readers, between nine and ten years of age, matched on the basis of birth date and school class. They used a ten item auditory-visual test which required the subject to match a visual dot pattern to a rhythmic auditory pattern tapped out by the examiner. They found that the retarded readers were significantly less able to make judgments of auditory-visual equivalence than were the normal readers. Moreover, among the normal readers those with lower auditory-visual test performance had the lower reading scores. When the IQs obtained on the Wechsler Intelligence Scale for Children (WISC) were correlated with auditory-visual test performance for all 200 children, the correlation coefficients were significant but low (.38 with Full Scale IQ, .27 with Verbal IQ, .30 with Performance IQ). No significant difference in auditory memory skills, as measured by the Digit Span subtest of the WISC, was found between high and low auditory-visual performers.

Following this Birch and Belmont (5) turned their attention to investigating the development of auditory-visual integration abilities in children between 5 and 12 years of age (kindergarten through sixth grade) using the same test as in their previous study. They found that growth in auditory-visual integration ability was most rapid between kindergarten and second grade. From the third through the fifth grades improvement was slow and steady. At the fifth grade an asymptote was reached and no further improvement occurred. Rank order correlations were computed for each grade level, except kindergarten, between auditory-visual scores and reading scores. For the first grade the correlation between reading readiness and auditory-visual performance was .70 ($p < .001$). For the second grade the correlation with reading achievement was .42 ($p < .05$). None of the

other correlations reached significance. They concluded that the development of auditory-visual integration skills is particularly important for young children in making them ready for formal learning and that this ability may well be a prerequisite to learning the reading skill.

In neither of these two studies was the reliability of the auditory visual test reported and the developmental study had no more than 23 to 30 children at any one grade level.

Kahn (9), in a concurrent study of the development of auditory-visual integration in relation to reading achievement, was able to remedy these deficiencies. She added ten items to the Birch and Belmont instrument in order to increase the reliability and raise the ceiling of the measure. Test-retest reliability for this 20 item measure was found to be .76 at the third grade level and .90 at the fifth grade level. In addition, 70 children were tested at each grade level from 2 through 6.

Using this longer test, Kahn found that mean auditory-visual scores continued to show improvement from grades 2 through 6 with the greatest increase in mean scores occurring between the second and third grades. Correlations between auditory-visual scores and vocabulary were significant for all grade levels except the second and ranged from .37 to .57. Correlations between auditory-visual scores and reading comprehension were significant at all grade levels and ranged from .42 to .49.

These results were in contrast to the Birch and Belmont finding of nonsignificant correlations with reading achievement after the second grade. Kahn attributed the difference in results to inadequate measurement of the older children due to a ceiling effect in their instrument.

So far as the writer has been able to determine, only one study has explored the relationship of tactual-visual performance to intelligence and reading achievement. Buchner (7) studied the relationship between tactual-visual interaction, intelligence and school achievement in fourth grade children. Subjects were required to explore a concealed geometric form tactually and then choose its counterpart from among four visual shapes. A 32 item test was used. He found a correlation of .61 between tactual-visual performance and vocabulary and a correlation of .60 with reading comprehension, both significant beyond the .01 level. These correlations are high compared with others in the literature relating perception to reading and suggest that the relationships should be explored further.

Problem. The present research had three major objectives. First, to provide a partial replication of Buchner's study to see if the high correlations he obtained would be substantiated. Second, to compare auditory-visual and tactual-visual performance to assess

their relative importance for academic achievement within a single group and to see how they relate to each other. Third, to look at the relationship of type of reading errors made on an oral diagnostic reading test to performance on the two intersensory tasks.

METHOD

Subjects

The sample consisted of 121 boys from five schools of a middle-class suburban community. The subjects were restricted to boys in order to eliminate the sex differences known to exist in reading achievement. All were white and American-born. Fourth graders were used since this was the age group on which Buchner's test was standardized. Every fourth grade boy in the five schools was tested in a room provided at the school. No child who presented evidence of a significant uncorrected visual or hearing defect, as determined by school screening techniques, was included in the sample. The mean age of the subjects was 9 years, 4 months.

Procedure

The testing was divided into two parts and took place from the third week in October through the second week in January. During the first testing period the auditory-visual and tactual-visual tests were administered to all subjects individually. The two tests were given in a standard order with the auditory-visual test always being administered first. In the second period (approximately three weeks later), all subjects were individually administered the reading diagnostic test. Scores on the group intelligence test (Henmon-Nelson, Revised Edition) and achievement tests (Iowa Tests of Basic Skills, Form 1) were obtained from official school records after the individual testing was completed.

The Tactual-Visual Integration Test. The tactual-visual integration test was developed by Buchner (7). In this test the subject explores tactually a raised geometric form which is out of sight. Then four visual geometric forms are exposed successively and he is required to choose the form which matches the one he felt.

The test involves the apparatus shown in Figure 1. A shield and box were constructed to hold the form boards in place while they were hidden from the subject's view. The subject inserted both hands into an opening in the front of the box in order to perceive tactually the single form which was the task. The vertical shield, which he could not see over or under, kept him from making a visual identification by accident or observing what his hands were doing. When he had finished exploring the task manually, he removed his

hands and raised the four windows on the shield, one at a time and always from left to right, until he selected by vision alone a match for the form he had felt. He was not allowed to put his hands back in the box to refresh his memory of the form.

Sixteen different geometric figures were used as tactual stimuli. Each single figure constituted a task board. Each task board was made of heavy cardboard 3½ inches square with 1/8 inch strips of balsa wood glued to it to form the raised geometric shape. In addition, there were eight visual choice boards each containing four raised geometric figures--three decoys and one correct form on each board. Figure 2 shows the eight choice boards with the correct answer indicated. Each choice board was 3½ inches by 14 inches, made of heavy cardboard, with forms made of balsa wood. The choice board was placed behind the shield and could only be seen through the windows. The correct match was randomly placed among the decoys so that the subject could not anticipate where it would occur.

Two practice task and choice boards (not shown) were provided for a short orientation period. The examiner had complete freedom to coach, correct, and demonstrate on the practice boards but no help was given once the test had begun. The subject was allowed to explore the figure tactually for 30 seconds and, after removing his hands, was allowed 5 seconds to look through each window. He selected his match as he went along; he was not allowed to look at all the choices and then return to pick one. The test consists of 16 trials. The eight choice boards are rotated 180 degrees for the second half of the test. Buchner used a total of 32 trials by presenting the sixteen figures first right side up and then upside down. The test was cut in half for the present study by eliminating the presentation of tasks upside down. This was done in order to effect a saving in the amount of individual testing time necessary for each subject. Test-retest reliability on the 16 item test for 30 subjects tested seven days apart was .63.

The Auditory-Visual Integration Test. In the auditory-visual integration test the subject is presented with a rhythmic auditory pattern tapped out by the examiner and is required to identify a visual dot pattern which matches it. The auditory patterns were tapped out with a pencil on a metal plate held below the table in order to hide the examiner's hand and arm movements. There was a half-second pause between short intervals and a one second pause between long intervals. The visual stimuli were covered during the tapping sequence.

In both the studies by Kahn (9) and by Birch and Belmont (4,5) there were three visual choices and they were presented simultaneously to the subject. Kahn's 20 item test (consisting of the Birch and Belmont instrument plus ten new items) was modified in the present study in order to make it comparable in format to Buchner's test--

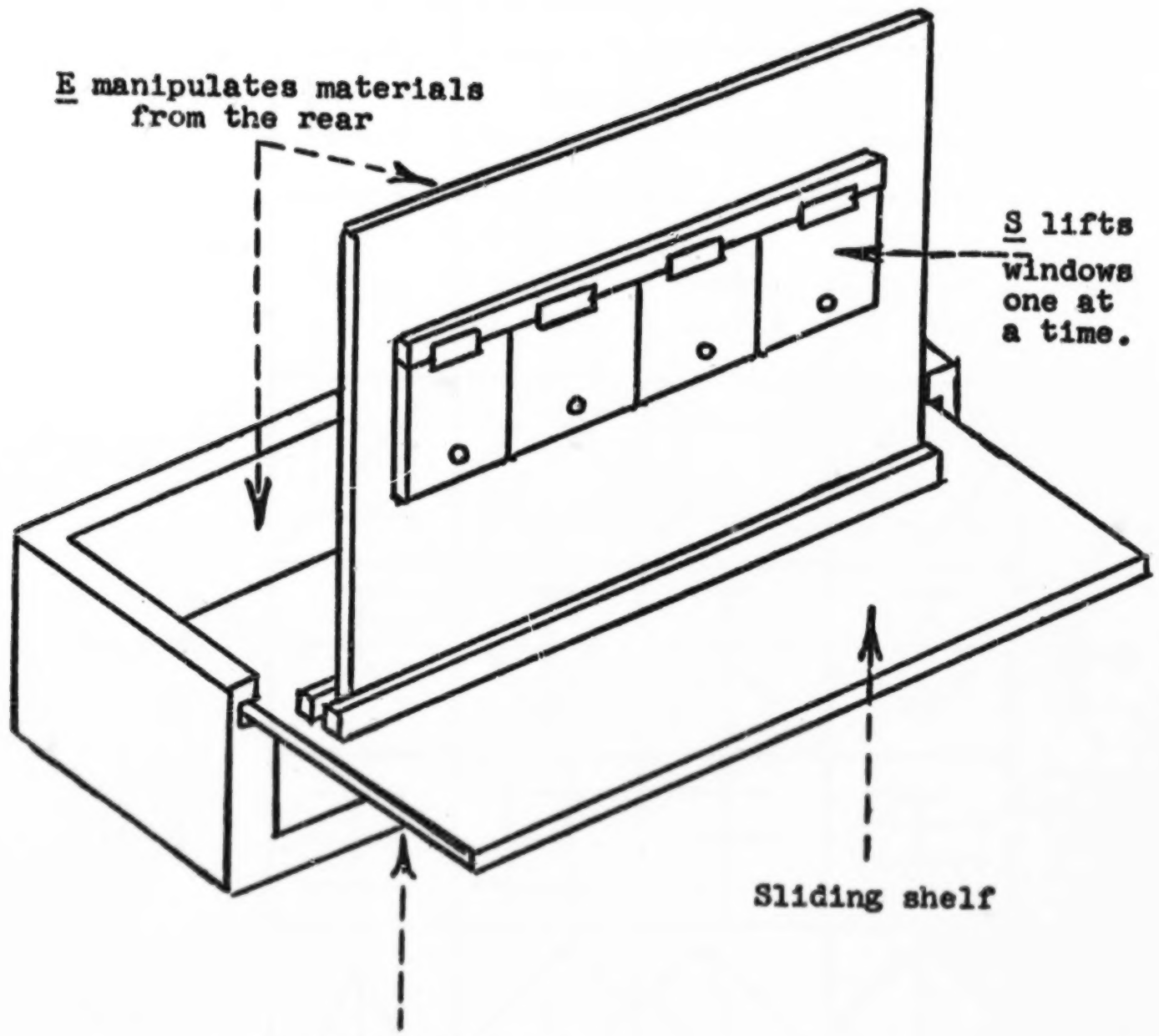

Figure 1

Shield and Box Used in

The Tactual-Visual Integration Test

Solution (as shown)	A	B	C	D	Solution (reverse board)
(Task 1) 1C					1B (Task 9)
(Task 2) 2B					2A (Task 10)
(Task 3) 3C					3A (Task 11)
(Task 4) 4B					4C (Task 12)
(Task 5) 5 A					5D (Task 13)
(Task 6) 6D					6C (Task 14)
(Task 7) 7D					7B (task 15)
(Task 8) 8C					8A (Task 16)

Figure 2

Eight Choice Boards Used In

The Tactual-Visual Integration Test

i.e. four rather than three alternative visual choices were used and they were presented successively rather than simultaneously. Each visual dot pattern was typed on a separate 4 x 5 inch index card and was exposed to the subject one at a time. The subject had to make his choice as he went along; he was not allowed to look at all the choices and then return to pick one. Figure 3 shows the visual choices with the correct responses to the auditory stimuli underlined. (Underlining did not appear on the test stimuli). The instructions were essentially the same as those given by Birch and Belmont. Test-retest reliability for 30 subjects tested seven days apart was .60.

In order to determine to what extent auditory memory is involved in performance on the auditory-visual test, 30 subjects were administered the Digit Span subtest from the Wechsler Intelligence Scale for Children (WISC). The relationship between the two tests, as measured by the Pearson product-moment correlation, was found to be .03. This finding is in line with previous results and indicates that auditory memory skills are not specifically associated with auditory-visual test performance.

The Diagnostic Reading Test. Two subtests of the Gates-McKillop Reading Diagnostic Test (8) were administered to all subjects. These were (a) Oral Reading and (b) Words: Untimed Presentation. The Oral Reading subtest provides a measure of paragraph reading whereas the Words: Untimed Presentation subtest presents words in isolation. A qualitative analysis of reading errors was made on the Oral Reading subtest. Both subtests were given according to the directions in the manual except that the analysis of reading errors was based on all seven paragraphs rather than on just the first four.

RESULTS

The data were subjected to both a quantitative and a qualitative analysis. In all tables the following abbreviations are used: auditory-visual test (AV), tactual-visual test (TV), Gates-McKillop Reading Diagnostic Test (G-M). The AV and TV results are in raw score units (number correct). The Henmon-Nelson IQ scores are deviation IQs. All data on reading achievement are in grade score units.

Quantitative Results

A comparison of the means and standard deviations of the two intersensory tests, as shown in Table 1, indicates that the AV test was generally found to be easier than the TV test by the subjects.

Examples

A ..	. .	...	. ..
B ...	. ...	. ..	.. .
C . ..	...	. ...	.. .

Test Items

1	. .. .	.. . .	.. ..
2	. ...	... .	. .. .
3	.. ...	... ..	.... .
4	.....	.. ..	. ...
5	.. ... .	. ... ..	... . ..
6	.. ...	.... .	.. . ..
7	... . ..	.. .. ..	.... ..
8	... .	... .	... .
9	.. ... .	... . ..	.. . ...
10	. .... .	. ... ..	.. . ...
11	. .... .	. ...	. ...
12	... .	.. ..	....
13	. ...	. .. .	. ...
14	.. ..	. ...	.. ..
15	....	....	....
16	.. ..	... .	....
17	... .	... .	... ...
18	. ...	. ...	. ...
19	... .	....	... .
20	... .	.. ..	....

Figure 3

Auditory-Visual Integration Test

Table 1

Means, Standard Deviations, and Ranges of Major Variables

(N = 121)

	AV	TV	IQ	Iowa Voc.	Iowa Rdg.	G-M Par.	G-M Words
Mean	12.10	6.07	106.17	4.48	4.23	5.23	5.23
S. D.	4.43	2.79	14.61	1.08	1.37	1.29	.98
Range	3-20	0-13	66-141	1.9-8.2	1.5-9.9	2.2-7.5	3.1-6.5

The principal findings of the study, as shown in Table 2, revealed that the correlation between the two intersensory tests barely reached significance at the .05 level and was so low that it cannot be regarded as representing a meaningful relationship. The AV test showed low but significant relationships with intelligence and reading achievement whereas the TV test correlations were too low, even where significant, to be meaningfully interpreted. The usual fairly high correlations between intelligence and reading ability were found.

Table 2

Correlations between Auditory-Visual Integration, Tactual-Visual Integration, Intelligence, and Reading Achievement

(N = 121)

	AV	IQ	Iowa Voc.	Iowa Rdg.	G-M Par.	G-M Words
AV	-	.34	.30	.28	.31	.27
TV	.17	.02	.14	.17	.03	.17
IQ	.34	-	.78	.73	.64	.67

r = .15 Significant at .05 level.
r = .21 Significant at .01 level.

The results with regard to AV integration and reading achievement were in agreement with Kahn's fourth grade results although the correlations were lower. This result could be due to the differences in test format and to sampling differences. The TV results, however, were in direct contrast to those obtained by Buchner and thus failed to replicate his study. A careful analysis of the two studies has failed to disclose any factor capable of accounting for the large discrepancy between them. The results of a pilot study done with a different sample suggest that with different samples and/or different measures, significant relationships between TV performance, intelligence, and reading achievement may be obtained. It does not appear likely, however, that the correlations would be as large as those obtained by Buchner.

Table 3 shows the results of partial correlations computed to determine the role of intelligence in the AV-reading relationships. Because no relationship was found between TV scores and intelligence, the partial correlations were computed for the AV scores only.

As was seen in Table 2, the AV test correlates to about the same extent with both intelligence and reading. Measures of reading and intelligence, in turn, share a large common variance. The partial correlations indicate that whatever the AV test has in common with reading is also in large part what it has in common with intelligence so that when intelligence is held constant the relationships are reduced to near zero. Thus because of the close relationship generally found between measures of intelligence and reading achievement, these partial correlations are seen as having relatively little meaning.

Table 3

Partial Correlations between Auditory-Visual Integration and Reading with Intelligence Held Constant

(N = 121)

	Iowa Voc.	Iowa Rdg.	G-M Par.	G-M Words
AV	.04	.05	.13	.06

r = .15 Significant at .05 level.
r = .21 Significant at .01 level.

The type of reading errors made on the diagnostic reading test and their relationship to performance on the two intersensory tasks was analyzed. The nine types of errors specified in the Gates-McKillop manual were used. In addition, because of the significance of reversal errors in reading and the desire to study this type of error more fully, three categories were added by the investigator as follows: Reversal of Words--such as are you for you are; Reversal of a Single Letter--such as b for d; and Total Reversals. There were two other summary categories: Total Mispronunciations--the sum of all error categories excluding Omissions, Additions, and Repetitions; and Total Errors--the sum of all errors made by an individual. Each reading error was entered in only one category.

There were conspicuously few Reversals of any type and also very few Additions. The major error types were Omissions of Words, Wrong Middles, Wrong Endings, and Wrong in Several Parts. Table 4 presents the correlations between reading errors and the major variables.

The low correlations found for a number of categories were probably due to the low frequency of errors in those categories. It is of interest to note the degree of relationship between intelligence and Full Reversal of Letters (which refers to errors such as was for saw). Why intelligence should be more highly related to this type of reversal error than to the other types is not readily explained. It is a rather striking finding insofar as the correlation is based on fewer cases than any other error category (eight cases in all) and yet it exceeds all but three in the table. The one significant correlation obtained between TV performance and reading errors was a positive relationship with Repetitions. A possible explanation for this relationship is that a child may repeat some words in reading in order to be sure he got them right. This habit of taking another look at what is read may be related to thoroughness of exploration on the TV task.

The Iowa Tests of Basic Skills yield three composite area scores in addition to the scores for vocabulary and reading comprehension. The composite scores are (a) Language Skills (the average of scores obtained on subtests measuring spelling, capitalization, punctuation, and usage); (b) Work-Study Skills (the average of scores obtained on subtests measuring use of maps, graphs, and reference materials); and (c) Arithmetic Skills (the average of scores obtained on subtests measuring arithmetic concepts and problem solving). Table 5 presents the correlations found between auditory-visual and tactual-visual scores and these three areas of academic achievement.

It is interesting to note that auditory-visual scores correlated more highly with these three areas of achievement than with any of the reading achievement scores. Likewise, the correlations of tactual-visual scores with Work-Study Skills and Arithmetic Skills were higher than those found for any of the other tactual-visual relationships. The correlation between tactual-visual performance and Work-Study Skills appeared to be substantial enough to represent some meaningful relationship.

Table 4

Correlations between Auditory-Visual Integration, Tactual-Visual Integration, Intelligence, and Reading Errors

(N = 121)

	Omis-sions	Addi-tions	Repeti-tions	Rev. Words	Full Rev. Letters	Rev. Parts	Rev. Sing. Letter
AV	-.22	-.05	.07	-.16	-.14	-.14	-.02
TV	-.05	.09	.18	.13	.02	.05	-.02
IQ	-.48	.12	-.07	.06	-.40	-.11	-.12

	Wrong Beg.	Wrong Middle	Wrong End.	Wr. Sev. Parts	Total Mispr.	Total Errors	Total Rev.
AV	-.04	-.11	-.21	-.22	-.26	-.30	-.21
TV	-.14	.10	-.02	-.09	-.06	-.03	.08
IQ	-.26	-.30	-.37	-.39	-.51	-.64	-.26

r = .15 Significant at .05 level.
r = .21 Significant at .01 level.

Table 5

Correlations between Auditory-Visual and Tactual-Visual Integration and Achievement in Language, Arithmetic and Work-Study Skills

(N = 121)

	Language Skills	Work-Study Skills	Arithmetic Skills
AV	.32	.35	.37
TV	.13	.26	.19

r = .15 Significant at .05 level.
r = .21 Significant at .01 level.

Qualitative Results

Tactual-visual performance was analyzed in terms of five aspects: (1) speed; (2) thoroughness of tactual exploration; (3) consistency in the use of one or both hands; (4) position choices (response set); and (5) methods used to solve the task.

It was found that the majority of the subjects performed the test rapidly using much less than the maximum time allowed and that those who scored high explored the figure more thoroughly than those who scored low.

In the instructions for the tactual-visual test the subjects were explicitly encouraged to use both hands for the task since it was felt that the use of both hands would lead to optimal exploration of the figure. It was then observed whether the subjects were consistent in the use of both hands or one hand or whether they alternated in their use of hands. Results showed that some children used both hands throughout the task, some used either the right or left hand alone, and some showed different patterns of alternation between one and two hands. For example, one child showed the following pattern: right-both-right-left. Another child's pattern was; right-both-left-both-left. This dimension was found to differentiate clearly between those scoring above and below the mean on the test with low scorers more inconsistent in their use of hands than high scorers.

Low scorers also made more systematic position choices than high scorers--i.e. they tended to choose either the first or the fourth visual alternative 50% or more of the time, indicating a type of response set.

At the conclusion of the test each subject was asked to describe how he did the task. It appeared that two major kinds of methods were used: (a) an attempt to visualize the figure or to get some mental image of it, and (b) a reliance primarily on kinesthetic cues. Examples of visualization responses: "I felt it and got a picture in my mind;" "Some made me think of something I've seen, like the roof of a house." Examples of kinesthetic responses: "I felt it and drew it in my mind;" "I drew the figure on myself." In general, visualization methods were used more frequently than kinesthetic methods in solving the task.

Auditory-visual performance was analyzed in terms of two aspects: (1) position choices, and (2) methods used to solve the task. As was the case with the tactual-visual test, making systematic position choices was associated with poor performance on the task.

The majority of the subjects used a counting procedure in solving the task but there were two types. In one case the taps were grouped into units separated by the pauses and each new unit began with the number one. Thus a pattern of taps such as this, ..., was counted 1,2,3--1,2--1,2,3. In the other procedure, the same dot pattern was counted consecutively, thus, 1,2,3--4,5--6,7,8. Subjects used either one procedure or the other, they were not interchangeable. A few subjects either denied counting or felt it was secondary and apparently used body movements primarily to do the task, usually by tapping fingers. Finally, there were some subjects who used both a counting procedure and some form of body movement--either head nodding or finger tapping or both. Reliance on body movements alone to solve the task was found predominantly in subjects scoring below the mean on the test.

DISCUSSION

The finding of a significant relationship between auditory-visual integration and reading does not seem too surprising in view of the common processes involved. Both tasks require comprehension of a temporal pattern of sounds and recognition of the same pattern when presented spatially on paper. It thus appears that the auditory-visual test measures the perceptual abilities involved in the development of vocabulary.

The auditory-visual test was found to correlate significantly with all but one of the major reading errors. Reversal errors occurred very infrequently in the sample. Despite this the correlations between auditory-visual scores and Total Reversals reached significance at the .01 level. It is felt that the auditory-visual task can be particularly useful in diagnosing reversal errors in reading since there is nothing inherent in the stimuli to indicate direction. The reader must impose his own sense of direction on the task. If the child has not acquired the habit of viewing visual stimuli from left to right, this is quickly made apparent. A number of the subjects asked which way to read the dots or started reading in the wrong direction on the practice trials. If they asked about direction, the standard reply was that it was up to them to decide. After going through the three practice trials, most of the children were able to correct themselves. It was clear, however, that a number of subjects were uncertain about direction and would have read the dot patterns from right to left if they had not been helped on the sample problems. It is felt that the relationship between auditory-visual scores and reversal errors would be higher at lower grade levels where such errors are likely to be more frequent.

The auditory-visual test was found to correlate significantly not only with reading achievement but also with Language Skills, Work-Study Skills, and Arithmetic Skills. It may be hypothesized

that what is common to these tasks is precisely this dimension of spatial or directional orientation, of right-left discrimination, which seems to account for the relationship between auditory-visual scores and reversal errors.

What seems to be emerging here is the fact that underlying reading abilities and all other aspects of educational achievement are certain basic dimensions rooted in the body image. As Kephart (10) has made clear, the concepts of directionality which are so important in reading are rooted in the bodily experience of laterality--the awareness that the body has a left and a right side. The projection outward of this bodily sense of laterality is what enables the individual to distinguish directions in space--to distinguish, for example, between a b and a d or a 6 and a 9. All other spatial coordinates are likewise projections from bodily experience into outside space.

It is not only reading which is fundamentally based on spatial orientation but arithmetic as well. Arithmetic is inherently a visual-spatial problem because it deals with groups of objects and the characteristics of groups and grouping phenomena. As Kephart points out, "If the child has not developed an adequate space world, he will have difficulty in dealing with grouping phenomena, since groups can only exist in space." (10, p. 94)

It is these basic spatial and directional abilities which the auditory-visual test appears to be getting at and which, it is hypothesized, account for the correlations with reading, arithmetic and the map and graph reading tasks involved in Work-Study Skills.

On the face of it, it would seem that the tactual-visual test also gets at these basic spatial and directional abilities. The stimuli are deliberately designed to elicit errors in directional orientation such as confusions between right and left, up and down. The importance of these factors in reading have been noted by Benton (2) and by Belmont and Birch (1) as well as a number of other writers. Right-left awareness and spatial orientation, in turn, are based on early integrations of tactual and visual clues (12, 13, 14). Kephart has put it most succinctly in stating, "Our first information about form and about the spatial relationships involved in form is kinesthetic and tactual." (10, p. 87)

On the basis of these theoretical and observational data there would be good reason to expect a relationship between tactual-visual abilities and educational achievement. The relationships would not be expected to be as high as those found by Buchner but neither would they be expected to be as low as those found in this study. It is possible that tactual-visual ability plays a more important role at earlier age levels than that represented in this investigation.

The present study found essentially no relationship between the two intersensory tasks. In contrast, Birch and Lefford (6) presented evidence that visual-tactual, visual-kinesthetic, and tactual-kinesthetic intersensory combinations were all significantly intercorrelated. Their three tasks, however, shared the same stimuli. It may be that correlations between various intersensory combinations will depend on the sharing of identical or highly similar content.

CONCLUSIONS

Previous research in auditory-visual and tactual-visual integration has been very limited and further research in both areas is necessary. It would seem to be of particular importance to explore further the relationship between tactual-visual performance and reading ability since the two studies which exist in this area have obtained diametrically opposed results. Certain theoretical and observational data suggest that a relationship between tactual-visual skills and reading ability might be expected. The confirmation or disconfirmation of this relationship is felt to have both theoretical and practical significance.

SUMMARY

The major purpose of the investigation was to study the relationship of auditory-visual and tactual-visual integration to intelligence and reading achievement. In addition, the relationship of the two intersensory tasks to each other and to the type of reading errors made on an oral diagnostic reading test was also explored.

The sample was composed of 121 white fourth grade boys drawn from a middle-class suburban community. The measure of tactual-visual integration was originally developed by Buchner and required the matching of a geometric shape felt out of sight to one among four visual choices. The measure of auditory-visual integration was a modification of a test developed by Kahn and required subjects to match a rhythmic auditory pattern with one of four visual dot patterns.

The tactual-visual test, auditory-visual test, and Gates-McKillop Reading Diagnostic Test were administered individually to all subjects. Scores on the Henmon-Nelson Intelligence Test and the Iowa Tests of Basic Skills were obtained from school records.

The data were subjected to a correlational analysis. The results showed that auditory-visual integration was significantly related to both silent and oral reading ability with correlations ranging from .27 to .31. Auditory-visual integration was also found to be significantly related to intelligence, with a correlation of .34. When intelligence was held constant, none of the relationships

with reading retained significance.

In contrast, tactual-visual integration was not found to be significantly correlated with either reading ability or intelligence.

The two intersensory tasks were not found to be significantly correlated with each other.

Auditory-visual integration was found to correlate significantly with the following reading error categories: Omission of Words, Wrong Endings, Wrong in Several Parts, and Total Reversals. There was no significant relationship between tactual-visual integration and reading errors.

Significant correlations were obtained between auditory-visual integration and achievement in Language Skills, Work-Study Skills, and Arithmetic Skills. Tactual-Visual integration related significantly only to Work-Study Skills.

A qualitative analysis of tactual-visual test performance revealed that (1) the majority of subjects performed the test rapidly using much less than the maximum time allowed; (2) those who scored high explored the figure more thoroughly than those who scored low; (3) low scorers were more inconsistent in their use of hands than high scorers; (4) low scorers made more position choices than high scorers; (5) visualization methods were used more frequently than kinesthetic methods in solving the task.

A qualitative analysis of auditory-visual test performance revealed that (1) position choices were associated with low performance on the test and (2) the majority of subjects utilized a counting procedure in solving the task. A few subjects, who scored below the mean on the test, relied on body movements alone to do the task.

The results of the study indicated that auditory-visual integration skills were significantly related to intelligence and reading achievement whereas tactual-visual integration skills were not. The findings with regard to tactual-visual functioning were in sharp contrast to a previous study by Buchner who found a high degree of association between tactual-visual performance, intelligence and school achievement. It was suggested that this discrepancy might be due to differences in samples and/or measures used. It was recognized that these results hold only for the types of intersensory tasks employed and that generalizations to other types of intersensory tasks could not be made.

REFERENCES

1. Belmont, Lillian, & Birch, H. G. Lateral dominance, lateral awareness, and reading disability. Child Development, 1965, 36, 57-71.

2. Benton, A. L. Dyslexia in relation to form perception and directional sense. In J. Money (Ed.), Reading disability. Baltimore: Johns Hopkins Press, 1962. Pp. 81-102.

3. Birch, H. G. Dyslexia and the maturation of visual function. In J. Money (Ed.), Reading disability. Baltimore: Johns Hopkins Press, 1962. Pp. 161-169.

4. Birch, H. G., & Belmont, Lillian. Auditory-visual integration in normal and retarded readers. American Journal of Orthopsychiatry, 1964, 34, 852-861.

5. Birch, H. G., & Belmont, Lillian. Auditory-visual integration, intelligence and reading ability in school children. Perceptual and Motor Skills, 1965, 20, 295-305.

6. Birch, H. G., & Lefford, A. Intersensory development in children. Monographs of the Society for Research in Child Development, 1963, 28, No. 5.

7. Buchner, L. J. The relationship of tactual-visual reciprocity to the intelligence and school achievement of fourth grade children. Unpublished doctoral dissertation, Teachers College, Columbia University, 1964.

8. Gates, A. I., & McKillop, Anne. Gates-McKillop reading diagnostic test. New York: Teachers College, Columbia University, Bureau of Publications, 1962.

9. Kahn, Dale. The development of auditory-visual integration and reading achievement. Unpublished doctoral dissertation, Teachers College, Columbia University, 1965.

10. Kephart, N. C. The slow learner in the classroom. Columbus, Ohio: Charles E. Merrill, 1960.

11. Maier, N. R. F., & Schneirla, T. C. Principles of animal psychology. New York: McGraw-Hill, 1935.

12. Maier, N. R. F., & Schneirla, T. C. Principles of animal psychology. (Enlarged ed.) New York: Dover Publications, 1964.

13. Monroe, Marion. Children who cannot read. Chicago: University of Chicago Press, 1932.

14. Piaget, J., & Inhelder, Barbel. The child's conception of space. London: Routledge & Kegan Paul, 1963.

15. Sherrington, S. C. Man on his nature. New York: Macmillan, 1941.